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Metallurgical Project

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DISTRIBUTION OF FISSION ACTIVITY IN METAL WASTE SOLUTIONS

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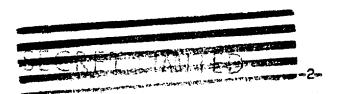
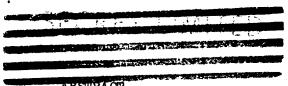


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ABSTRACT

The 360,000 gallons of waste solution under consideration contain 77.3 tons of metal from the first 290 days operation of the Clinton 200 Area. It is stored in waste storage tanks W-10, W-7, and a small amount of W-9. That in W-9 will be mixed with an equal volume of fresh waste and the mixture used to fill W-7. The distribution of fission product activity in these tanks, important for a consideration of metal recovery, has been estimated from the fission yields and decay curves of the individual elements combined with a day by day survey of the metal discharged from the pile.

Allowing for the fact that incomplete separation from Zr. Cb. Ce and Pr is obtained in the first product precipitation, the results indicate that the activity in the waste tanks as of September 1, 19hh is the same as that from "average" metal irradiated at 15 KW per ton for 100 days, and allowed to decay 130 days. The distribution of activity and rate of decay are moreover similar to such metal. The calculated activities of the individual fission products expressed as curies and beta and gamma watts for additional decay times are summarized in Tables 2 and 3.

INTRODUCTION

A knowledge of the distribution of fission products in the metal waste solution is important for a consideration of methods of recovering the metal. After two years cooling, for example, 96% of the gamma activity is due to 36 year Cs. The best method of separating the uranium from the fission product activity at such a time would be to precipitate the uranium leaving the Cs in solution. For shorter cooling times, however, other methods of decontamination such as solvent extraction might be more efficient. As an alternate to analyzing the waste for the various fission products, the distribution of activity may be estimated from the fission yields and decay curves of the individual elements. Such curves are available from MUC-NS-212 (Project Handbook Chapter III, Section D6).

Values of pils operating power, irradiation and decay times necessary to apply the curves are found from a day by day survey of the metal discharged from the pile. These calculations have been carried out as follows:



Tracing the Source of Metal

According to the usual procedure, the metal is discharged from the pile into marked buckets for storage in the canal. Before it is sent to the 200 Area, it is redistributed in other buckets to give a more uniform concentration of product in each batch. This mades it difficult to trace the source of metal from 200 Area records. By assuming, however, that all the metal discharged from the pile up to a certain date was processed and stored in the waste storage tanks, the history of the metal may be traced from Building 105 *Detail Charging and Discharging Records. * These records give the charging and discharging dates and the amount of product associated with each batch calculated on the basis of 24,000 KW hours per gram 49 This allows determination of irradiation and decay times as well as pile operating level for any given metal. By the time they were full, tanks W-9 and W-10 contained all metal discharged from the pile up to July 5. 1944 (plant runs 1 to 202) plus four/sevenths of the metal discharged from July 5 to July 17, 1944 (runs 202 to 208). The remainder of the waste from these latter runs is still held in small storage tank W-4.

After W-9 and W-10 were filled, the waste in W-9 was partially transferred to W-7. The 40 of liquid remaining in W-9 will be mixed with an equal amount of fresh waste from W-4 and the mixture used to fill W-7. The activity of the W-7 waste must, therefore, be based on a forecast of the activity of the fresh waste which will be added.

To be sure that all of the metal pushed from the pile from the beginning of operations to July 17 was processed in the 200 Area, a product balance as of August 12 was used.

This showed that the amount delivered by August 12 (from daily reports) plus amount delivered during August 12 to August 28 plus the canal inventory was within about 1% of the amount pushed, according to "Detail Charging and Discharging Records."

Calculations

Having determined the irradiation and decay times for each batch of metal, the power level may be found from the amount of h9 in the metal and the time of irradiation. Thus,

$$P = \frac{W}{T} \times 10^6$$

where, P = power level, watts.

W = weight of product, gms.

T = time in pile, days.

Activities of the individual fission elements in curies or beta and gamma watts as a function of P, T and t (the decay time) are next found from data in MUC-NS-212 or Project Handbook, Chapter III, Section D6. The activities of the Zr, Cb, Ce and Pr must be corrected for incomplete decontamination in the first product precipitation. Only 75% of the Zr and 90% of the Cb. Ce and Pr activities go into the metal waste.

Comparison of Calculated Activity with Measured Activity

Measured activities as of September 1, 1944:

Assuming 8% geometry, 100% efficiency for beta counts, 1% efficiency for gamma counts gives for beta

$$\frac{3.67 \times 10^{6} \times 180000 \times 3785}{(.08) (3.7 \times 10^{10}) 60} = 14000 \text{ beta curies}$$

for gamma

$$\frac{1.5 \times 10^{14} \times 180000 \times 3785}{.08 \times .01 \times 3.7 \times 10^{10} \times 60} = 5700 \text{ gamma curies}$$

This compares to calculated values of 28000 and 14000 curies for beta and gamma respectively.

Results

The total amounts of each fission element in the waste tanks on September 1, 1944 are given in Tables 2 and 3 as well as activities at future dates. A comparison of W=10 activities with values calculated on the basis of "average" metal tradiated at 15 KW per ton for 100 days and allowed to decay 130 days is given in Table 4. The calculated activities are higher for the Zr. Cb. Ce and Pr by amounts expected from the specific decortamination data in the report by W. Q. Smith, 5/1/44, "Handling of Metal Wastes."

Measure total activities are about 50% of calculated total activities.

Table 2

Activity of Fission Species in W-10 Storage Tank*

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o
11400
2100 1400 700
28000 7200 3900 2100

*Contains 180,000 gallons of waste (37.8 tons of metal),

Table 3

Estimated Total Activities in W-7 Storage Tank*

Species		Curies as of		Swatts as of		Y watts as of	
		3/1/45	9/1/45	3/1/45	9/1/45	3/1/45	9/1/45
Sr 89	554	1000	100	Ŀ.o	0.4	0	0
sr ⁹⁰	30y)	300	30 0	0.4	0.4	o	0
_¥ 90	60h)	300	300	1.6	1.6	0	0
_Y (92)	57a	1000	100	3.6	0.4	0	0
zr ⁹³	65 d	2000	300	1.9	0.3	8.6	1.2
съ93	35a	2500	300	2°5	0.3	10.4	1.5
Ru103	40 d	250	10	0.2	0	0.9	0
Ru	330a)	800	500		}	0	0
Rh	30 s)	800	500	(4.0	2.8	0	0
Te 129	32 d)	()
Te 129	72m	20	0	0.1	0 .	0	0
Ca ¹³⁵	36 y	<i>2</i> 50	250	0.4	0.4	0.7	0.7
Ba ¹⁴⁰ 1	2.5 d)	1	0	0	0	0	Ç
la ^{11;0}	40h	1	O	0	0	O	Q
Ce ¹⁴¹	28 d	200	2	0.3	0	0.2	, e
Pr ¹⁴³ 1	3.5 d	1	0	0	0	0	a
Ca	340a)	jt000	3 00 0	<u>∫</u>		o	0
Pr	17m	4000	3000	30.8	21.3	0	0
Totals		30000	10000	50	30	20	4

Will contain when full 180,000 gallons of waste (38.7 tons metal).

.Table 4

Activity of fission species in W-10 as of September 1, 1944.

Activity of fission species calculated on basis of metal reacted at 15 KW/ton for 100 days, cooled 130 days.

Element	Curies	Watte B	Watts &	Curies	Watts B	Watts &
55d Sr	3000	12.1	0	3000	12.1	0
30% Sr	200	0.3	C	180	. 2 5	0
50h Y	200	2.0	0	180	9ء	. 0
57a Y	3400	11.0	0	3300	10.9	0
65d Zr*	3600	3• 7	16.2	i 4700	4.7	21.4
35d Cb*	7300	%•3	31.8	8800	7 .5	37.4
40d Ru	1200	J.8	3.5	1000	0.7	2.8
33d Ru	300	•		360		
30s Rh	300	3 .2	0	360	3.5	0
32d(724) To	140	0.3	0.1	120	. 2 5	.06
36y C1	150	0.3	0.5	120	-38	.48
12.5d Ba	200	0.6	0	30	.0 5	0
40h !a	200	0.9	2.5	30	.10	. 31 4
28d Jø	1400	2.2	1.9	1050	1.4	1.21
13.5d Pr	5 /10	0.5	0	30	.07	0
34Cd Ce*	3100			3600		
17a Pr*	3100	22.5	0	3600	26.8	0
TOTAL	28000	65.7	56-5	30400	69 6	63.7

^{*}The Zr, Cb, Ce and Pr activities in the waste are lower than calculated due to partial predipitation of these elements with the first product precipitation.